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A novel approach to significantly increasing the field of view (FOV) of night vision goggles (NVGs) has been developed and demonstrated. This approach uses four image intensifier tubes instead of the usual two to produce a very wide 100 degree horizontal by about 40 degree vertical FOV. A conceptual working model, designated the Panoramic NVG, has been fabricated and evaluated.

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Development and Evaluation of the Panoramic Night Vision Goggle

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Abstract

A novel approach to significantly increasing the field of view (FOV) of night vision goggles (NVGs) has been developed and demonstrated. This approach uses four image intensifier tubes instead of the usual two to produce a very wide 100 degree horizontal by about 40 degree vertical FOV. A conceptual working model, designated the Panoramic NVG, has been fabricated and evaluated.

Introduction

The Panoramic NVG (PNVG) [1], [2] is a revolutionary change to traditional image intensifier-based night vision devices. The initial focus of the PNVG project centered around developing an "enhanced capability" NVG. A primary candidate parameter for enhancement was the NVG FOV with other parameters such as resolution, weight, center of gravity, and integrated display symbology overlay as secondary objective enhancements.

A conceptual working model was developed and fabricated (Figure 1) that displays a 100 degree horizontal by 40 degree vertical intensified FOV (Figure 2). This increased the intensified image seen by the wearer by 160 percent compared to the currently fielded 40 degree circular field of view systems. The larger FOV was achieved by using four off-the-shelf image intensifier tubes to produce four ocular channels. Two channels were used to produce a full 30 degree by 40 degree binocular FOV, and the other two were used to produce monocular left and right eye channels of about 35 degrees by 40 degrees. The PNVG's folded optical system resulted in a much better center of gravity compared to the currently fielded AN/AVS-6 and AN/AVS-9 type NVG configuration. Even with the added image intensifier tubes and associated optics, the overall weight of the device was comparable to currently fielded NVGs. The larger FOV and better center of gravity should reduce fatigue effects during long missions and potentially permit the PNVG to be retained upon ejection for use in evasion, escape, and rescue.

Fig. 1 PNVG Conceptual Working Model

desired F/1.44 inner objective lenses and F/1.7 outer objective lenses were incorporated along with an eyepiece effective focal length of 21.9mm. Physical eye relief was measured to be approximately 17mm (Figure 4).

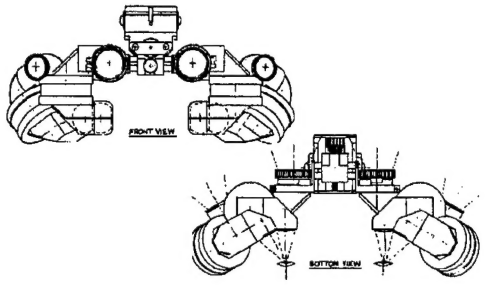

Fig. 4 Schematic diagram of the PNVG

A single inter-pupilary distance adjustment enables the wearer to align the eyepieces for their individual requirements. System power (AA alkaline batteries or standard military batteries) and mechanical mounting hardware are identical to the fielded systems thereby allowing for simple operation and compatibility for attachment, stow, and detachment of the PNVG.

PNVG Evaluation

Laboratory assessments were done on the PNVG for visual acuity under various illumination conditions (for the binocular FOV only) and for total visible FOV. To assess visual acuity, three trained observers looked through the PNVG at a chart composed of patches of square-wave gratings in a series of increasing spatial frequencies. The observer selected the highest spatial frequency grating that he/she could resolve then walked backward until the selected grating was barely resolvable. The baseline observation distance for the chart was 30 feet. The final angular spatial frequency of the grating (cycles/degree) was calculated by multiplying the base spatial frequency times the ratio of the walk-back distance to 30 feet. These data were then converted to cycles per milliradian (in parentheses below) and to Snellen acuities (numbers in front of the numbers in parentheses). This was done three times for each observer for each illumination condition. Each ocular of the PNVG was measured separately then a binocular assessment was made. The results shown below correspond to the median visual acuity (or resolution in cycles per milliradian) value obtained from the three observers:

MedianVisual Acuity (Resolution)

"Starlight Conditions"

Left channel	Rt. channel	Binocular
93(0.37)	93(0.37)	93(0.37)

"Quarter Moon Conditions"

Left channel	Rt. channel	Binocular
44(0.78)	40(0.86)	42(0.82)

Testing FOV was a bit more difficult due to the very large FOV and the nature of the partial binocular overlap. The PNVGs were positioned in a mount fixed to an optical bench, and observers viewed through the PNVGs to determine how far they could see to the edge of the FOV for each ocular. This spot was marked on the wall and trigonometry was used to determine the field angles. Since the far wall used for this assessment was only about 12 feet away, precise results could not be obtained. The median FOV values for the three observers are shown below:

have a tremendous impact on nighttime performance.

Acknowledgments

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